# Microscopy and Magnification Notes

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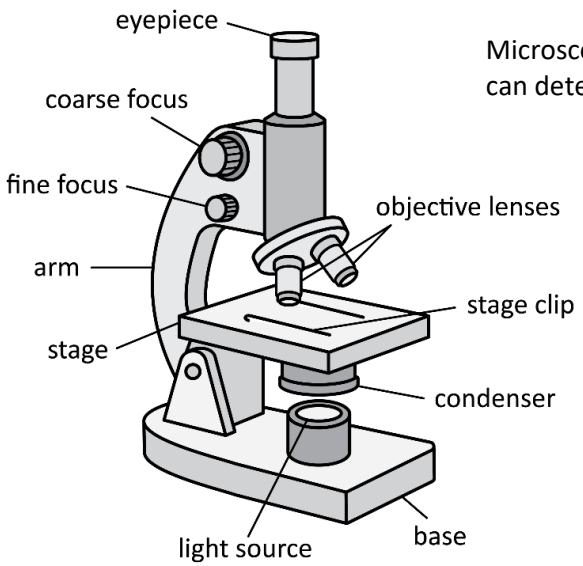
**A microscope**: an instrument that allows a person to magnify an object. The object can be magnified tens, hundreds, thousands, tens of thousands even hundreds of thousands of times. The figure below shows a light microscope.

**Exam note**: We may be asked to label a light microscope. Please do learn the following labels.




Microscopes allow us to see microorganisms, by being able to see them we can determine how their structures relate to their function.

Of all the techniques used in biology, microscopy is quite possibly the most important.

The vast majority of living organisms are far too small to be seen in any detail with the naked eye, and cells and their organelles can only be seen with the aid of a microscope.

Microscopes have two properties:

1. **Magnification.**
2. **Resolution**.

**Magnification**: a dimensionless number, usually written as a magnification factor, for example x100. It is simply indicating how much bigger the image is than the original object.

**Resolution**: a distance, usually measured in nanometres (nm). It is the smallest separation at which two separate objects can be distinguished.

The table below shows the effect of magnification and resolution on the appearance of two small objects.

| | Low resolution | High resolution |
|---|---|---|
| Low magnification | | |
| High magnification | | |

## Electron Microscopes

The technology of microscopes has improved massively in the last 100 years. In that time electron microscopes have been developed, instead of using light, electron microscopes use a beam of electrons to form an image of the specimen. Electron microscopes have **two major advantages** over light microscopes. These are:

1. **Higher magnification**: Electron microscopes can magnify objects up to x2,000,000 times compared to the x2,000 maximum of a standard light microscope.

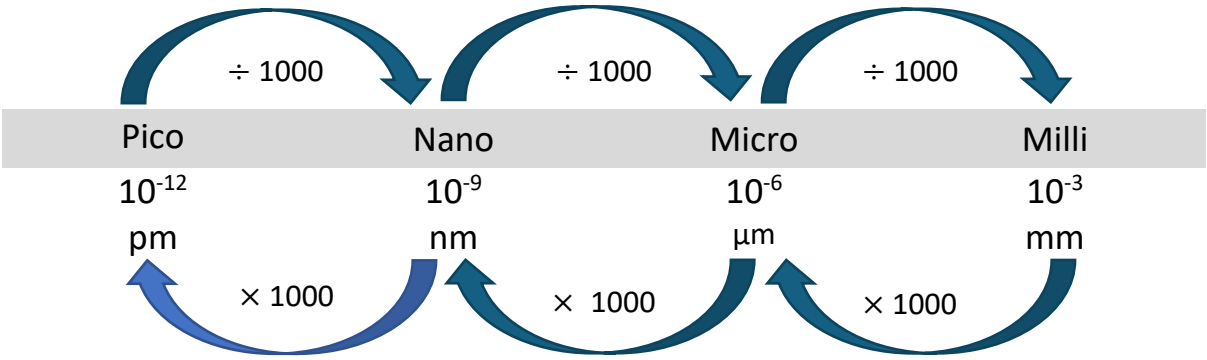
2. **Higher resolution**: Electron microscopes have a much greater resolving power. This means they can distinguish between two very close points, producing a much sharper, clearer image.

   **Why is the resolution better?** Electrons have a much shorter wavelength than visible light.

**Are there any disadvantages of electron microscopes?** Of course 😊 they are way bigger more expensive than light microscopes and the specimen that we are observing has to be dead because it's in a vacuum.

## Converting Units

We do need to be able to convert between the different quantitative units in relation to cells. When teaching this I use this handy table. I hope it helps you 😊.




## Calculating the Magnification of Light Microscopes

If the magnification of the eyepiece and the compound lens are known we can multiply them both to get the full magnification. Check out the example below.

**Example 1**: Find the magnification of a microscope. The eyepiece is x10 and the compound lens is x40.

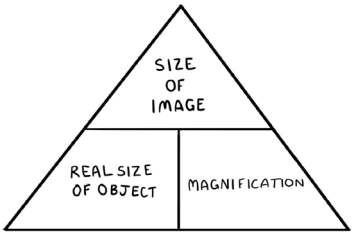
$$\text{Magnification} = 10 \times 40$$

$$\text{Magnification} = \times 400$$

## Calculating the Magnification of an Image

The formula to calculate magnification is:

$$\textbf{Magnification} = \frac{\textit{Size of the image}}{\textit{Real size of the object}}$$

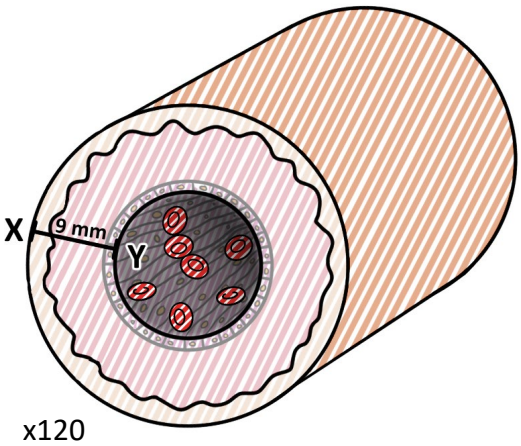



I often recommend using the triangle for this calculation. I find it makes rearranging the equation quicker.

Take the following example.

**Example 2**: The diagram shows a section through an artery.

Calculate the thickness of the wall of the artery between the points marked X and Y.
Give your answer in **micrometres**.




**Step 1**: Convert the mm into µm by multiplying by 1000.

$$9 \text{ mm} \times 1000 = 9000 \text{ µm}$$

**Step 2**: substitute the values into the equation.

$$\text{Real size} = \frac{\textit{Size of the image}}{\textit{Magnification}}$$

$$\text{Real size} = \frac{9000}{120}$$

$$\text{Real size} = 75 \text{ µm}$$